OPEN AS A MATTER OF PRINCIPLE

ABIERTO COMO CUESTIÓN DE PRINCIPIO

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Abstract: *The Marburg Building System is one of the earliest, most consistent and internationally best-known German building system. Its development marks the beginning of the doubling of the German university building stock in just 20 years. The building site at Marburg Lahnberge was possibly the most consulted example for university planning in the 1960s and 1970s. Meanwhile, the qualities of the buildings are seldom appreciated, the system's intrinsic facility for modification, adaptation to new user requirements or extensions are not used. The architectural quality of the buildings, erected on the Lahnberge campus in Marburg, their consistent approach down to the details, the technical innovation of the serial production of building elements in an on-site field factory and the thorough planning process to standardise all building components is indeed remarkable. The underlying principle of openness bears considerable potential to prolong the lifespan of the buildings, if, as a start, the existing defects are repaired. The advantages of the buildings, their basic system and the underlying concept may not be obvious, but on closer examination, they are undeniable. They could and should be utilised.*

Keywords: *Building system; university architecture; construction history; building process; monument preservation; campus planning.*

Resumen: *El Marburg Building System es uno de los sistemas constructivos alemanes más pioneros, coherentes y conocidos internacionalmente. Su desarrollo marca el inicio de un proceso en el que se ve duplicado el conjunto de los edificios universitarios alemanes en solo 20 años. El emplazamiento de Marburg Lahnberge fue, posiblemente, el ejemplo más consultado para la planificación universitaria en los años 60 y 70. Sin embargo, pocas veces se aprecian las cualidades de los edificios, siendo poco explotada la facilidad intrínseca del sistema para modificar y adaptarse a los nuevos requerimientos de los usuarios. Pese a ello, es realmente notable la calidad arquitectónica de los edificios construidos en el campus de Lahnberge en Marburg, la coherencia de su estrategia hasta la escala de detalle, la innovación técnica de la producción en serie de sus elementos de construcción fabricados in situ y el proceso de planificación minucioso para estandarizar todos los componentes del edificio. El principio subyacente de apertura tiene un potencial considerable para prolongar la vida útil de los edificios, si se reparan los defectos existentes. Las ventajas de los edificios, su sistema básico y el concepto base del proyecto pueden no ser obvias, pero al examinarlas desde más de cerca, son innegables. Todo ello podría y debería utilizarse.*

Palabras clave: *Sistema constructivo; arquitectura universitaria; historia de la construcción; proceso constructivo; preservación de monumentos; planeamiento de campus.*

The system buildings of the 1960s have come under criticism, while the reasons for their development have fallen into oblivion. Many of the buildings are ageing poor. They seem to be incomprehensible if their basic concepts are ignored and the main influence of strategies for optimisation and rationalisation are not taken into consideration. While expressive prototypes, objects of famous architects and utopian large-scale visions from the boom years meanwhile gain recognition, the large mass of system buildings are hardly appreciated – despite the fact that their underlying core concepts aim at openness, growth and modification and are therefore intrinsically sustainable.

The Marburg Building System[1] is one of the earliest, most consistent and most consulted examples for university planning in the 1960s and 1970s. The development of the, presumably, internationally best-known German building system marks the beginning of the doubling of the university building stock in just 20 years. To realise the potential of the buildings constructed on the basis of the Marburg Building System, knowledge about the political, social and economic background seems necessary: Planning in the 1960s was still fundamentally affected by the prevailing belief in continuous growth, progress and technology. The total standardisation of building elements should facilitate the rationalisation of the building process by using serial production methods to rapidly eliminate the lack of educational facilities. What is more, the institute buildings constructed at Marburg Lahnberge accommodate the basic demand for variability, flexibility and extensibility. The system is open to change.

THE GERMAN POSTWAR UNIVERSITY

The extension of existing universities and the construction of newly established ones were some of the most important and largest Postwar building tasks. The planning did not follow its own building tradition: the science institutes' buildings were modelled on contemporary architecture for office buildings, the overall concept derived from campuses in England, Scandinavia, the Netherlands[2] or the USA.[3] During the *boom years*,[4] university planning was particularly influenced by newly conceived

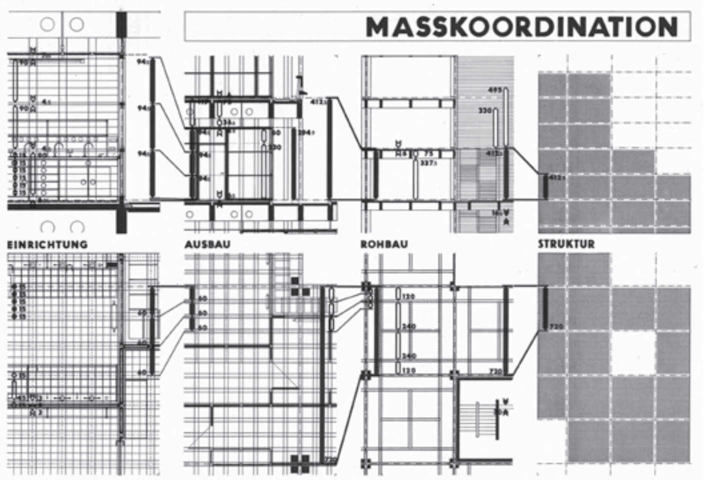

FIG. 01

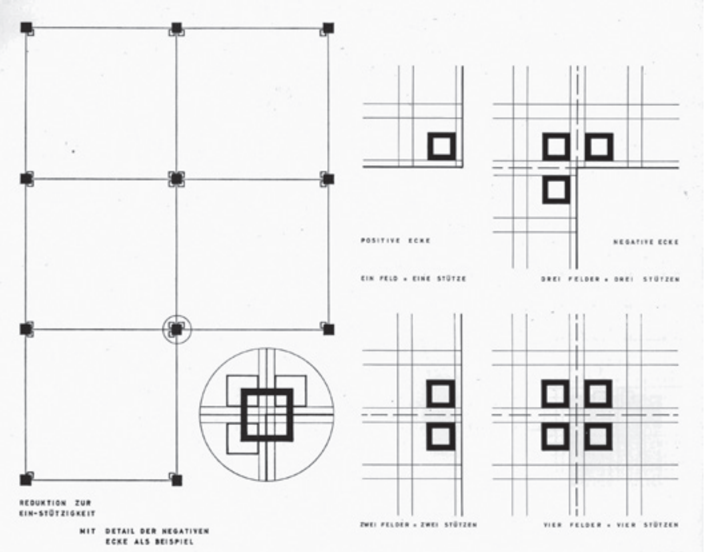

FIG. 02

educational policies and subsequently developed concepts adapting the changing organisation and structure of a university.

The ongoing debate about education policy was tightening by the end of the 1960s, provoked by Georg Picht, who prophesied the 'German education disaster' in the beginning of the 1970s.[5] According to Picht, the problem in the education sector was founded on the increase in pupil numbers, which will be followed by a shortage of teachers and of educational facilities. He argued further that the problems could not be solved in the short term nor without an immediate programme of action. Thereupon the Republic and the States declared the expansion of universities to be a common task, which was detailed in a new 'University Building Promotion Act'. Starting in 1971, the Planning Committee for University Building drafted a plan for the expansion of the university sector every year.[6] The planning incorporated increasing student numbers, regional distribution of universities, necessary application requirements and the overall development goal. To achieve the latter as quickly as possible, experiments concerning the optimisation of the planning process and the rationalisation of the production of university buildings were revived and intensified. By the end of the 1970s, more than two million square meters of floor space had been created in the university sector, as well as approximately 300,000 new places to study.[7]

The buildings at Marburg Lahnberge were already planned at the beginning of this period of development in 1961. They were constructed as part of the first big campus extension of a German university, which made them archetypes for many following plans.

BASICS AND CHARACTERISTICS

The specific characteristics of the Marburg Building System are its openness, a tartan grid, structurally independent *table units* and resulting multiple columns as well as a reverse order of planning: the furniture and fittings are developed first, then the necessary installations to supply all the rooms, followed by equipment and fittings. In the third stage, the finishes were planned, including interior and exterior walls, and last, the independent supporting structure followed **(FIG. 01)**.

The measurements of the system are developed based on the smallest scale unit. The tartan grid is based on a line with a width of 15 centimetres. The basic unit of this system is 60 centimetres, which is the distance separating two tartan lines. This is a multiple of the line width, adjusted to different functional room and interior dimensions. The basic unit has a vertical height of 7.5 centimetres. Because of ergonomic, functional and technical production considerations, it is half the width of a tartan line and accounts for the size of the smallest chest of drawers or shelving units. The height between floors derives from the stair slope and measures three metres for work areas.[8]

The tartan grid is the primary grid of the Marburg Building System and is separated from the construction grid of the load-bearing elements. It is used for all industrially prefabricated, non-load-bearing exterior and interior walls, cabinet walls, laboratory furniture and installations. By making the two grids distinct, wall elements and columns do not meet, thus preventing the need to shorten walls and produce different sized elements.

The constructive grid of the load-bearing table units is secondary to the tartan grid; its axes run through the middle of the tartan lines. The field size of the constructive grid, and consequently of the table units, is defined by the depth of illumination, which measures between 6 and 8.4 metres. In order to accommodate wall elements, which are two, three and four units long, the axes of the construction grid are 7.2 metres apart. To get different field sizes and therefore more options for floor plan layout, in addition to the standard or normal field (7.2 x 7.2 metres), there is a large field with a one-third extension (9.6 x 7.2 metres), as well as a one-third shorter small field (4.8 x 7.2 metres).

Each table unit has its own vertical support elements with a column at each of the four corners. The columns measure 30 by 30 centimetres for buildings with less than 8 floors, and 45 by 45 centimetres for buildings with 8 to 18 floors; they support every fields' ceiling, which is a lattice of beams. A distinction is drawn between main beams, central beams, axial beams and edge beams. Axial beams run uninterrupted between the columns of adjacent table units and therefore contradict the idea of their complete structural independency.

In order to allow individual fields to be added and freely combined, the structural system of the Marburg Building System is non-directional. The sequential addition of table units leads to the characteristic multiple columns. A maximum of four columns is placed around one point. An advantage of this multi-column system is that none of the edge or corner columns are oversized and negative corners can also be easily solved **(FIG. 02)**.

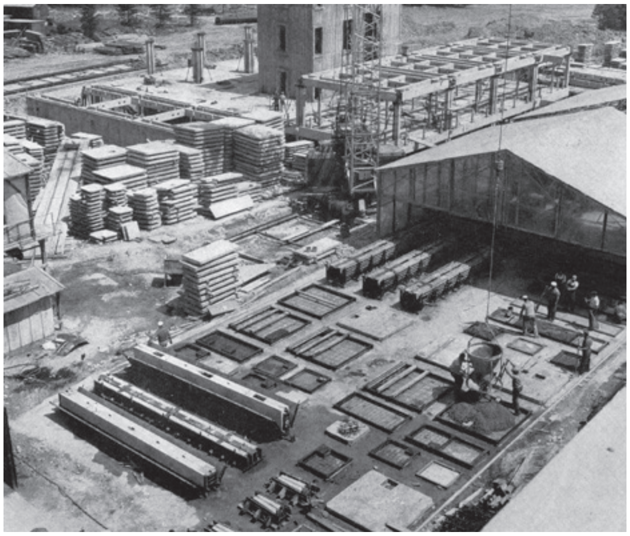

FIG. 03

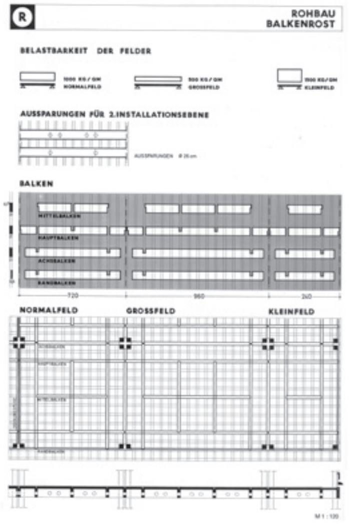

FIG. 04

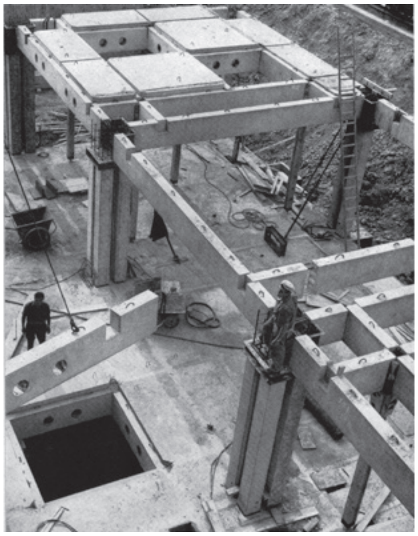

FIG. 05

ORIGIN OF THE SYSTEM AND ITS FORERUNNERS

The building system was originally designed by Helmut Spieker for an extension of the University of Kiel, as part of his diploma project under Egon Eiermann at the Technical University of Karlsruhe in 1958. After working as Eiermann's assistant, Spieker became project leader at the Karlsruhe University Building Authority, where he worked on large extensions of the inner-city campus, using his formerly developed system as a basis. Here, the notable four-column cluster characteristic of the Marburg System and the structurally independent table units shows up for the first time, while the tartan grid and the quadrat as a fundamental geometrical proportion had already been developed for the diploma project. Spieker relocated from Karlsruhe to Marburg in 1961, where further developments of his system were made for the new campus and finally carried out for the first time.

Marburg University was founded in 1527[9] and looks back on a long university building tradition in the city centre, where there was no space available for another large extension.[10] It was decided in 1961 that the campus extension would be built on the area of Marburg Lahnberge. This decision necessitated building new infrastructure, including area development and transport connections to the city. It offered the chance to design a new kind of university architecture and to create a campus following English and American examples.

LAHNBERGE CAMPUS

The master plan for the Lahnberge campus was developed in 1961/62 by Winfried Scholl.[11] As the first step, the complete area was subdivided into a three-dimensional grid based on the system's numerical order. The final form of the science institutes' buildings was undetermined until "the moment of a concrete state of planning, influenced by definite user demands",[12] providing conditions that allow designs to respond to changing spatial requirements. This includes the definition of larger planning structures for different faculties and university groups, as well as the development of an infrastructure for heat, water and electricity that did not restrict the planning of buildings. In addition to a multi-lane road connecting the campus with the inner city, transport planning included smaller building service roads and pedestrian paths, parking areas as well as bus and railway connections to public transport. The Lahnberge campus has its own power station for safeguarding the heat supply, with water tanks and waste incineration in close proximity. The control station for electricity and telecommunication was built centrally. The entire campus and all the buildings are supplied with heat by an accessible and developable subterranean utility system with a cross-section of 2 metres height and about 3.5 metres width. Water and gas pipes are placed in a gravel bed along one side of the access channel, while pipes for electrical lines run along the opposite side.

The entire infrastructure system of the Lahnberge campus was considerably oversized and still offers the possibility of having large-scale, continuous campus development. The original Marburg plan scheduled a building volume of 2.5 million cubic metres, and only around half of it was actually realised until 1980.[13]

PRODUCTION OF BUILDING ELEMENTS AND CONSTRUCTION

In 1962, a competition for the construction of the first two building projects was publicly announced.[14] The company Hochtief made a proposal involving reinforced concrete construction and won the job. A serial production of building elements was encouraged, due to the large mass of buildings to be constructed out of a limited number of different parts based on the underlying standardised system. Hochtief initiated the construction of an on-site prefabrication plant **(FIG. 03)**.[15]

As a basis for production, a catalogue of all standardised and combinable elements was developed **(FIG. 04)**. Using steel formwork, structural concrete elements were mass-produced on-site: columns, beams and ceiling slabs with integrated anchor tracks for connecting suspended ceiling and facade elements.

The realisation of the first prototypical buildings started with laying out all service and water pipes, followed by concrete groundwork, baseplates and casting cores on-site in concrete.[16] After finishing the ground floor, the assembly of prefabricated concrete elements of the building system was started. In the yards, columns were assembled into pairs using steel collars, which acted as supports for the edge beams during assembly. Firstly, the column pairs were placed as single units, followed by the edge beams and the main beams, which were borne upon brackets

FIG. 06

FIG. 07

in the edge beams. Finally, the inner beams were assembled, where necessary with built-in openings to allow installations to pass through.

The ceiling slabs were laid on the lattice of beams **(FIG. 05)**. Then the intersection points of the beams above the columns were filled up with concrete. The head of the columns already contained the connections for columns of the next floor. In this manner, the structure was built floor-by-floor.

FINISHES AND INTERIOR

The raw skeletal building structure allows for a high degree of freedom in the design of the floor plans. The non-structural interior and exterior wall elements can be placed freely and, in principle, can also be replaced.[17] They shared the same connection details and measurements. In addition, the interior closet elements were designed to allow a direct connection to the walls. The company Rudolf Chillingworth AG Nuremberg, department L. A. Riedinger metal construction, produced the wall elements as completely prefabricated steel frames with integrated plastic profiles (Neoprene) to clamp into different filling materials.[18] The wall elements were fixed with a screw spring between the lattice of beams and the floor **(FIG. 06)**. The floors and soundproofing sub-construction were fitted with numerous connections to allow for maximum flexibility. The heating system, based on a loop layout, also matches the grid, as do the electrical rails and ventilation ducts.[19]

Instead of designing complete pieces of standardised furniture or installations, the fixture system was developed to allow multiple standardised elements to be differently combined. Also here a catalogue was provided that details all dimensions and types for standard furnishings.

SYSTEM BUILDINGS AT MARBURG UNIVERSITY

The first building to be completed using the Marburg building system was the three-storey office building of State University Planning Authority for New Buildings, serving as a prototype. In 1965, the building was awarded a prize for exemplary achievement by the State of Hessen and the Union of German Architects.

In 1966, the five-storey building for pre-clinical research followed, requiring a high level of technical building services to be provided, as it housed laboratories and special rooms needed for teaching and research. It was also planned as a prototype for the following system buildings.

The large and most famous clusters of chemical institutes were constructed from 1967–1971, demonstrating the full scope of the building system.[20] The complex floor plan of the staggered multi-storey building showed positive as well as negative angles; it enclosed several inner courtyards, laboratories **(FIG. 07)**, working areas and office space, rooms for teaching, storage and building services. The main complex housed the organic, inorganic and biological chemistry institutes. In the smaller, separate part of the complex were the institutes for high polymer and nuclear chemistry.

An auditorium building was connected to the chemical institutes complex. Built out of large-scale concrete slabs, it was based on a specially developed building system because of its representative role for the university. The roof was designed as a hanging construction **(FIG. 08)**. All surfaces were left raw. Around the same time, the smaller building complex for the biological institutes was constructed. It consisted of the main building for the institutes with offices, laboratories and numerous teaching and exercise rooms, and of different greenhouses as well as a central workshop space. At the beginning of 1970, the construction of a central building for the natural sciences started. It was already part of the immediate relief building plan, financed by both the federal government and the states.

PROBLEMS AND POTENTIAL

Despite their conceptual and constructive clarity, the system buildings in Marburg pose numerous problems today. This is mainly due to flaws in the building quality and high maintenance costs: the use of exposed concrete and not well-proven building materials, for example, has resulted in an unsightly ageing **(FIG. 09)**.

Another important factor is also the rushed process of construction, which manifests today as corrosion and leaks along the facades and on the roofs.[21] In addition, many of the buildings, as with many other universities founded or extended in the 1960s and 1970s, have not been well maintained, resulting in renovation congestion since the beginning of the 21st century, not to mention a generally bad public reputation.

Due to the utilisation of serially prefabricated building elements and industrially manufactured components, the manual reparability of the institute buildings is clearly limited.[22] The building mass and

FIG. 08

consequently large number of identical parts in need of simultaneous replacement would imply a serial repair measure for defect elements or their optimised replication. The original concept of flexible adaption to changing circumstances, resulting in the separation of structure and interior fittings and the development of specific details, could then prove itself.[23] For example, existing shortcomings in terms of building quality and climate control[24] could be fixed relatively easily through replacement or supplementary insulation of the original facade elements, under the condition that these measures are in accord with the concept of conservation for the since 2013 protected buildings.[25]

The quality of the Lahnberge campus buildings realised with the Marburg Building System should not be judged only on the basis of their present state. The materials' capacity for aging and repair, the construction and technical innovations, and the functionality of the buildings after fifty years of use must also be taken into consideration. Most of the buildings still fulfil their original task and are, according to their initial intention, adaptable to changing conditions – a feature which has hardly been exploited. While all of the university campuses from the 1960s and 1970s are designed to accommodate expansion and in fact were extended in the decades following due to increasing student numbers, none of the extensions make use of the original building system **(FIG. 10)**.

Towards the end of the 1970s, a distinct shift away from the planning principles of the boom years is notable. They were replaced by ecological strategies and economical concepts.[26] Theories that had been the basic principles for planning and building for two decades, lost their validity in the face of an increasing awareness for the limitations of natural resources,[27] despite the fact that they are future-oriented and intrinsically sustainable, due to their demand for adaptability.

The architectural quality of the Lahnberge campus buildings, their consistent approach down to the details, the technical innovation of the serial production in an on-site field factory and the thorough planning process to standardise all building components is remarkable. The underlying principle of openness bears considerable potential to prolong the lifespan of the buildings, if, as a start, the existing defects are repaired. Their advantages, their basic system and the underlying concept may not be obvious, but on closer examination, they are undeniable.

ACKNOWLEDGMENT

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Notes and bibliographic references

[1] This article is based on the more detailed elaboration of the topic, published in 2013: Silke Langenberg, *Marburger Bausystem: Open as a Matter of Principle* (Sulgen: Niggli Verlag 2013).

[2] Gunther Lorf, *Planen und Bauen für die Universität Dortmund*: *1964 bis 1993* (Dortmund: Gesellschaft der Freunde der Universität Dortmund, 1994).

[3] "[...] First used at Princeton University in the late eighteenth century, the Latin word *campus*, meaning 'field', became common as an expression for an ensemble of buildings [usually] for higher education. [...] campus planning is a thoroughly 'American tradition'." Stefan Muthesius, *The Postwar University: Utopianist Campus and College* (New Haven/London: Yale University Press, 2000), 24.

[4] Silke Langenberg, *Bauten der Boomjahre: Architektonische Konzepte und Planungstheorien der 60er und 70er Jahre* (Dortmund: Wulff, 2006).

[5] Georg Picht, "Die Deutsche Bildungskatastrophe," *Christ und Welt* 17, no.5 (1964): 3–5; no.6 (1964): 8–9; no.7 (1964): 4–5; no.8 (1964): 3–5.

[6] "Die rechtlichen Grundlagen der Gemeinschaftsaufgabe Hochschulbau seit 1970," in *15 Jahre Rahmenplanung für den Hochschulbau 1970–1985: Eine Dokumentation* (Bonn: Ed. by Planungsausschuß für den Hochschulbau, 1985), 7.

[7] "Die rechtlichen Grundlagen der Gemeinschaftsaufgabe Hochschulbau seit 1970," 23.

[8] All specifications, details and dimensions of the system based on: *Marburger Bausystem: System, Katalog, Methodik, Projekt* (Marburg, Kempkes: Marburger Universitätsneubauamt, 1971).

[9] Christian Bode, Werner Becker and Rainer Klofat, Eds, *Universitäten in Deutschland. Universities in Germany* (Munich/New York: Prestel, 1995), 292.

[10] Werner Fritzsche, Joachim Hardt and Karlheinz Schade, *Universitätsbauten in Marburg 1945–1980: Baugeschichte und Liegenschaften der Philipps-Universität* (Marburg: Universitätsbibliothek Marburg, 2003), 190.

[11] "Universitätsbau in Marburg a.d. Lahn," *Hochtief Nachrichten* 37, no.12 (1964): 2.

[12] Citation originally in German. *Marburger Bausystem: System, Katalog,* 61.

[13] "The planned building volume is around 2.5 million cubic metres of enclosed space." Citation originally in German. In: "Universitätsbau in Marburg a.d. Lahn," 2. The built volume carried out in Marburg up until 1980 adds up to about 1.2 million cubic metres of enclosed space. Calculations based on data of the different buildings in *Universitätsbauten in Marburg 1945–1980*, 255–264. After 1980, only a few single buildings were realised.

[14] *Universitätsbauten in Marburg 1945–1980*, 851.

[15] In the beginning of the 1960s, there were just a few prefabrication factories. But the situation changed fast. Just between 1961 and 1963, the number of prefabrication factories increased from 14 up to 500. From: Walter Meyer-Bohe, *Vorfertigung: Handbuch des Bauens mit Fertigteilen* (Essen: Vulkan, 1964), 174 (table).

[16] The cores of the prototypical buildings were carried out with in-situ concrete. For the cores of subsequent buildings prefabricated slabs were used. "Universitätsbau in Marburg a. d. Lahn," 8.

[17] The replacement of the wall elements was in the end more difficult than promised, not just in Marburg and not because of the construction or connection details, but because of fire zones and safety reasons. For flexibility of the Marburg Building System, see: Silke Langenberg, "Flexibilität und Zweckmäßigkeit: Das Marburger Bausystem," in *Wolkenkuckucksheim: Internationale Zeitschrift zur Theorie der Architektur* 17, no.32 (2012): 76–84. Online publication under: www.tu-cottbus.de/theoriederarchitektur/Wolke/wolke_neu/inhalt/de/heft/ausgaben/112/Beitraege/3.1%20%20%20Langenberg.pdf (16.06.2013).

[18] "Universität Marburg: Wandelemente für das Marburger Bausystem," published by Staatliches Universitätsneubauamt Marburg in *Bauwelt* 56, no.20/21 (1965): 578–581.

[19] Rudi M. Frank, "Modell Marburg: Universität auf Zuwachs," Ed. by Hochtief Aktiengesellschaft, 16-mmFilm, Essen no date (presumably end of the 1960s).

[20] *Universitätsbauten in Marburg 1945–1980,* 259.

[21] *Universitätsbauten in Marburg 1945–1980,* 265. In Marburg, all flat roofs and terraces were completely renovated between 1973 and the beginning of the 1980s.

[22] Silke Langenberg, "Das Konzept 'Ersatz'? Probleme bei der Reparatur industriell gefertigter Bauteile," in Bayerl, Günter and Georg Stöger (Eds.), *Reparieren – oder die Lebensdauer der Gebrauchsgüter*, no. 3 (Berlin: edition sigma, 2012), 255–272.

[23] In 2018 and 2020 two PhD projects started, that research the flexibility of the Marburg Building System (Dominik Gehring, PhD TU Munich) and on its potential for retrofitting (Benjamin Zweig, University Kassel).

[24] "However, from today's perspective, the system shows serious failings: A high liability to atmospheric influences and the existence of thermal bridges negatively affect the energy balance of the buildings." Citation originally in German. Hessisches Ministerium für Wissenschaft und Kunst, www.hmwk.hessen.de/ under: Hochschule > Hochschulpolitik > Bauprogramm HEUREKA > Philipps-Universität Marburg > Campus Lahnberge (12.03.2012).

FIG. 09

FIG. 10

[25] The following buildings are listed monuments: former State University Planning Authority for New Buildings, chemical institutes including auditorium, power station ensemble, botanical garden with associated buildings (administration and greenhouses). State Office for Conservation Hessen, June 2013.

[26] Richard J. Dietrich, "Von Metastadt zu Ökostadt: Denken und Planen in Systemen," in Schneider, Martina J. *Systeme als Programm,* (Cologne: Rudolf Müller, 1989), 19–29.

[27] Donella H. Meadows et al, *The Limits to Growth. A Report for the Club of Rome's Project on the Predicament of Mankind.* (New York: Universe Books, 1972).

Figures

FIG. 01. Coordination of dimensions of furniture, interior, fabric and structure. © Staatliches Universitätsneubauamt Marburg.

FIG. 02. Reduction to one column with detail of negative corner as an example, multiple columns: solution with one column (positive corner), two columns (two neighbouring fields), three columns (negative corner) and four columns (four fields meeting in one place). © Staatliches Universitätsneubauamt Marburg.

FIG 03. Aerial view of on-site field factory with storage of prefabricated building elements, construction site in the background. © Staatliches Universitätsneubauamt Marburg.

FIG 04. One Page (out of 23) of the system catalogue. © Staatliches Universitätsneubauamt Marburg.

FIG 05. Assembly of the lattice of beams. © Staatliches Universitätsneubauamt Marburg

FIG 06. Interior wall element between two columns of load bearing structure. © BUSSENIUS AND REINICKE

FIG 07. Laboratory of chemical institutes. © BUSSENIUS AND REINICKE

FIG 08. Auditorium building. © BUSSENIUS AND REINICKE

FIG 09. Aging of meanwhile protected system building in Marburg. © BUSSENIUS AND REINICKE

FIG 10. Old chemical institutes in Marburg and new buildings of campus extension in the background. © BUSSENIUS AND REINICKE

Bibliography

- Bode, Christian, Werner Becker and Rainer Klofat, Eds. *Universitäten in Deutschland. Universities in Germany.* Munich/New York: Prestel, 1995 (2nd edition 1996).
- Dietrich, Richard J. "Von Metastadt zu Ökostadt: Denken und Planen in Systemen." In: Schneider, Martina J. *Systeme als Programm,* 19–29. Cologne: Rudolf Müller (= *arcus: Architektur und Wissenschaft* 8), 1989.
- Frank, Rudi M. "Modell Marburg: Universität auf Zuwachs." Ed. by Hochtief Aktiengesellschaft. 16-mmFilm, Essen no date.
- Fritzsche, Werner, Joachim Hardt and Karlheinz Schade. *Universitätsbauten in Marburg 1945–1980: Baugeschichte und Liegenschaften der Philipps-Universität.* Marburg: Universitätsbibliothek Marburg, 2003.
- Langenberg, Silke. "Das Konzept 'Ersatz'? Probleme bei der Reparatur industriell gefertigter Bauteile." In: Bayerl, Günter and Georg Stöger (Eds.). *Reparieren – oder die Lebensdauer der Gebrauchsgüter*, no. 3, 255–272. Berlin: edition sigma, 2012 (= *Cottbusser Studien zur Geschichte von Technik, Arbeit und Umwelt* 79).
- Langenberg, Silke. "Flexibilität und Zweckmäßigkeit: Das Marburger Bausystem." In: *Wolkenkuckucksheim: Internationale Zeitschrift zur Theorie der Architektur* 17, no.32 (2012), *Funktion – Zweck – Gebrauch in Architektur und Städtebau*.
- Langenberg, Silke. *Bauten der Boomjahre: Architektonische Konzepte und Planungstheorien der 60er und 70er Jahre*. Dortmund: Wulff, 2006 (2nd edition 2011).
- Langenberg, Silke. *Marburger Bausystem: Open as a Matter of Principle*. Sulgen: Niggli Verlag, 2013.
- Lorf, Gunther. *Planen und Bauen* für die Universität Dortmund: *1964 bis 1993*. Dortmund: Gesellschaft der Freunde der Universität Dortmund, 1994.
- Meadows, Donella H. et al. *The Limits to Growth. A Report for the Club of Rome's Project on the Predicament of Mankind.* New York: Universe Books, 1972.
- Meyer-Bohe, Walter. *Vorfertigung: Handbuch des Bauens mit Fertigteilen*. Essen: Vulkan, 1964.
- Muthesius, Stefan. *The Postwar University: Utopianist Campus and College.* New Haven/London: Yale University Press, 2000.
- Picht, Georg. "Die Deutsche Bildungskatastrophe." *Christ und Welt* 17, no.5, no.6, no.7 & no.8 (1964).
- Staatliches Universitätsneubauamt Marburg. "Universität Marburg: Wandelemente für das Marburger Bausystem." *Bauwelt* 56, no.20/21 (1965): 578–581.
- VV.AA. "Die rechtlichen Grundlagen der Gemeinschaftsaufgabe Hochschulbau seit 1970." In: *15 Jahre Rahmenplanung für den Hochschulbau 1970–1985: Eine Dokumentation*. Bonn: Ed. by Planungsausschuß für den Hochschulbau, 1985.
- VV.AA. "Universitätsbau in Marburg a. d. Lahn," *Hochtief Nachrichten* 37, no.12 (1964).
- VV.AA. *Marburger Bausystem: System, Katalog, Methodik, Projekt.* Marburg, Kempkes: Ed. Marburger Universitätsneubauamt, 1971.

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